Journal of Problem Based Learning in Higher Education

VOL. 8, NO. 1, – Page 106-118
10.5278/ojs.jpblhe.v8i1.2645

Integrating Disciplines with PBL at the Autonomous University of Nuevo Leon (UANL)

Carlos Estuardo Aparicio, Karen Hinojosa, Amanda Melissa Casillas Zapata *

ABSTRACT

Problem-based learning is one of the most useful resources in education with the potential to effect real world change. The evident benefits of PBL in the face of the challenges that Latin America presently encounters have led many institutions to consider the adoption of PBL curricula. However, PBL implementation has its own set of difficulties. "I liked to work in a multidisciplinary team because our skills were complemented. Sometimes, it was difficult to understand our different ways of working, because we were focused on different things", said one of the students of our institution. This paper describes how different academic programs from the Autonomous University of Nuevo Leon (UANL) in Mexico, were integrated in a Learning Unit (LU) using the Problem Based Learning (PBL) methodology. First, we present some PBL definitions to delineate its main characteristics, like the students facing real problems. Afterwards, we describe the PBL implementation process at our university, its precedents, the administrative process, and the adaptation into an existing LU. Additionally, we describe how we adapted the PBL methodology to the Sustainable Ecological Environments course while also integrating the United Nations' (UN) Sustainable Development Goal (SDG) 11, dedicated to cities and sustainable communities. Finally, we mention some findings from the Sustainable Ecological Environments LU. Most notably, the students favour working in multidisciplinary teams and the amount of student investment was higher than in traditionally taught courses. Nevertheless, multidisciplinary work means a constructive challenge for teachers, because it involves a closer monitoring of the student's learning process and a different time distribution than traditional courses, with a higher time investment during planning stages.

* Carlos Estuardo Aparicio, Autonomous University of Nuevo Leon, Mexico
Email: caparicio55@yahoo.com
Karen Hinojosa, Autonomous University of Nuevo Leon, Mexico
Email: hinojosakaren@gmail.com
Amanda Melissa Casillas Zapata, Autonomous University of Nuevo Leon, Mexico
Email: melissa.casillas@gmail.com

Keywords: Multidisciplinary approaches, Public Health, Industrial Design, Architecture, Sustainability

INTRODUCTION

Problem Based Learning (PBL) is an academic method where students acquire knowledge and develop skills for investigating and for responding to real problems (Barrows, 1986). The problem is the departure point, and in order to tackle the problem, organized groups of students develop academic projects. The projects are supported by courses where students obtain theoretical and methodological tools. The participation of a supervisor is necessary; nevertheless, the collaboration between the students groups, the supervisor, and external partners is significant. One of the core concepts of PBL is that students have the responsibility for their own learning (Askehave et al., 2015). Savery (2015) remarks that "PBL is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem".

This paper delineates the PBL implementation process at the Faculty of Architecture from the *Universidad Autónoma de Nuevo León* (UANL) in a multidisciplinary LU, starting with its precedents, until some findings from this experience. The precedents include the official contact of the UANL Campus Team with the PBL methodology at the CITYLAB Meetings in 2016, and the implementation of four pilot groups since the beginning of January 2017 until December 2017, as well as the results from that preliminary experience that contributed to design the final PBL course. Also in this section, the administrative process for creating an interfaculty PBL course is mentioned. Subsequently, the section "Adapting PBL to an existing LU" describes the procedure where two members of our campus team designed a final PBL course that consists in a multidisciplinary class based in an existing LU, integrating students from three undergraduate programs of the UANL.

In this course, students from undergraduate programs on Nutrition, Architecture and Industrial Design participated with Ph. D students, guided by five UANL teachers and two international Citylab consultants. These teachers were specialists in subjects like Bioclimatic Architecture and Urbanism, Public Space, and Social Sciences among others. The undergraduate students were divided in multidisciplinary teams from the three different programs; meanwhile the two Ph.D. students were teaching aides (TA), acting as advisors among the teams. The students decided to work on the urban context of the UANL Health Campus. They detected problems like lack of security, informal commerce and congested traffic, but they decided to work on the more visible problem of pollution and garbage.

Finally, we conclude with some findings from the final PBL course implementation, like the necessity to integrate more interfaculty elective projects along the university. The knowledge and skills acquired by our students while facing real problems was encouraging, and reinforces the plan of replicating the course. In order for replicability to be successful, we include some findings about both teacher's and student's expectations and challenges.

THE PBL IMPLEMENTATION PROCESS

To describe the PBL implementation progression at UANL, we mention some precedents and the administrative process for creating an interfaculty PBL course.

The precedents

Our first formal contact with PBL methodology was during the CITYLAB Inception Meeting, in Antwerp, Belgium in February, 2016, where the participant institutions decided to work on the 11th of the Sustainable Development Goals (SDGs) (UNDP, 2015). This particular goal strives to make cities and human settlements inclusive, safe, resilient and sustainable. After the Lima CITYLAB Workshop, in October 2016, we designed and implemented two workshops with teachers at the Faculty of Architecture from the UANL, with the intention of disseminating PBL into other courses and potentially growing our campus team.

Later, in January 2017 the first PBL implementation started on a pilot group at the Faculty of Architecture, inside the LU called *Urban Workshop I*, a 5th Semester course for architects (Facultad de Arquitectura UANL, 2018). This course had 16 sessions and it considered the participation of Campus Team members and stakeholders. Additionally, the PBL pilot group received the class in English. The subject for that course was the creation of a residential development in the municipality of General Escobedo, located at the north of the Monterrey Metropolitan Area (MMA). The implicated stakeholders were the authorities from the Urban Development Department of the mentioned municipality and Real Estate Developers that owned the site.

Because of administrative reasons regarding course openings and availability each semester, our PBL course wasn't fixed consistently to a LU. We adapted its content and methodology into available courses that fulfilled our criteria, namely, a course at the undergrad level, which could be enriched by having an urban problem as a starting point. It is also worth mentioning that Urban Workshop I and II projects are the same for the whole school, and project exhibition fairs are held at the end of the semester where comparison between different classes' solutions is possible.

Subsequently, during the Summer Course 2017, we implemented another PBL module with a second pilot group, in the LU named *Urban Workshop II*, a 6th Semester course for architects. This course also received the participation of Campus Team members and stakeholders. The subject for that course was the requalification of the Urban Core of Matamoros, Tamaulipas, a city located at Mexico-US border. The involved stakeholders were people from the Urban Development Office from the municipality of Matamoros.

Continuing with the process of adapting the PBL methodology, in the Fall Semester 2017, the third and fourth pilot groups were carried out for the LU Urban Workshop I and II. For the first of these courses the subject was the creation of a residential development nearby an ecological area in south of the MMA. The implicated stakeholders were Real Estate Developers. For the Urban Workshop II the subject the requalification of the UANL District. The project included the surrounding areas to the university campus, located in two municipalities from the MMA. The participating stakeholders were authorities from the municipalities of San Nicolas de los Garza and Monterrey, as well as people from the UANL.

In the four cited cases, we observed an enthusiastic involvement of the students until the midterm session, going together with a good presentation of their works. Nevertheless, the final presentation was not extraordinary. A space for student feedback was provided after each course implementation. In the last pilot group, feedback was through an online survey using Google forms. Among the results of this survey, the students expressed that the workload was higher in a PBL course than in a regular course, and that having a multidisciplinary team of teachers left them sometimes confused and contradicted about their feedback, mentoring and opinions. The majority of students, 78.6%, totally agreed that the PBL course encouraged collaborative work, as we can see in figure 1. A high percentage of students, 78.5%, agreed that the PBL course helped them better understand class concepts when compared to a traditional course, as seen in figure 2.

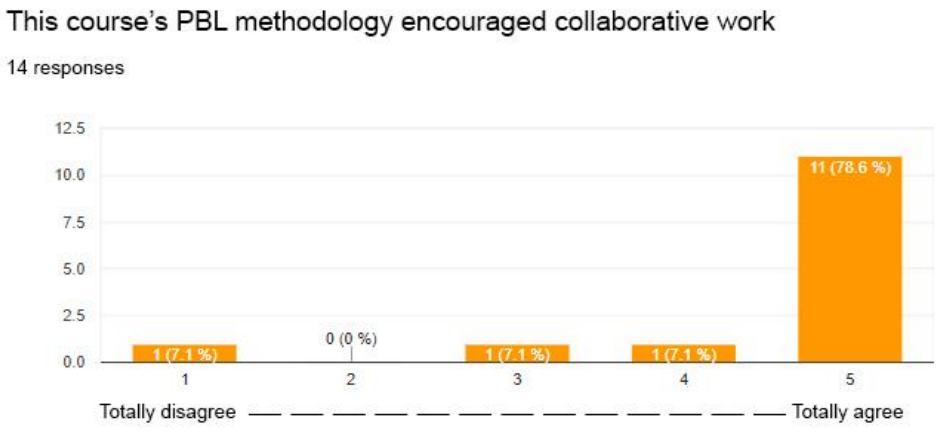

Figure 1. Students answer to the question of whether the PBL course encouraged teamwork.1 is Totally disagree and 5 is Totally agree.

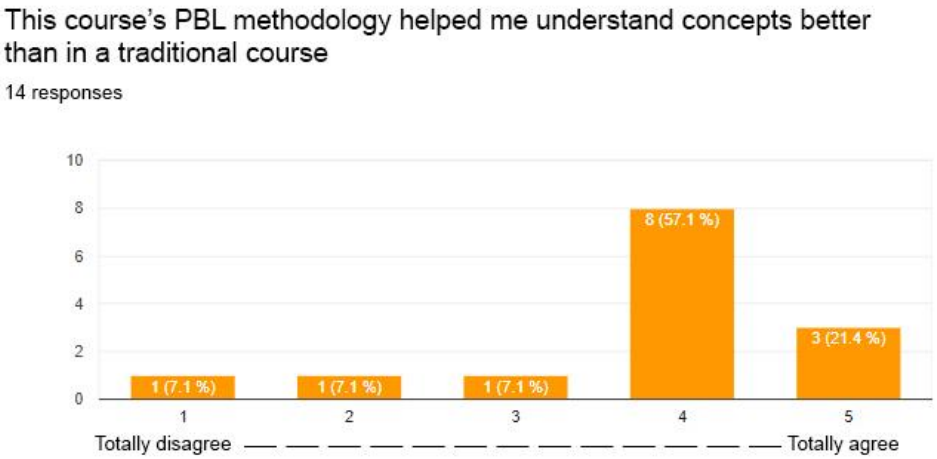

Figure 2. Students answer to the question of whether the PBL course helped to better understand class concepts when compared to a traditional course.1 is Totally disagree and 5 is Totally agree.

Based on the experience of the four pilot groups and the feedback of teachers and students that participated, the campus team members redesigned the PBL module. Also, the exchange of experiences that took place with the other universities in the CityLab meeting that took place in September 2017 in Buenos Aires, Argentina, contributed to the restructuring of the course. The integration of multidisciplinarity was done in varying degrees by all the participating members, according to their needs and possibilities. After hearing about the initial experiences of teams that took a greater multidisciplinary approach, the challenges of greater variety of disciplines in students, teachers and problem approach, seamed surmountable, and the benefits tangible. Consequently, the decision was reached that both student and teacher teams had to be multidisciplinary. We understood that the module in its prior form lacked flexibility to implement it adequately and we decided to create a new PBL course, considering multidisciplinary, multi-knowledge, and multilevel students issues and integrating an interfaculty team of teachers. We conducted some research on successful integration of disciplines in educational curricula, and concluded that in order to successfully manage multidisciplinarity in our course, all disciplines involved needed to be task oriented and focused on what their strengths where towards problem-solving (Salmon Cox et. al, 1977). At the same time, 15 teachers from the Faculty of Architecture and the Faculty of Public Health and Nutrition were in the process of completing the PBL Online training on the University of Antwerp platform, strengthening our original team. The experience of creating the new PBL course, its implementation and their final results after these changes were implemented are explained in the next section.

The administrative process for creating an interfaculty PBL course

The UANL (2011) Academic model considers the elective LU inside the curricula of each academic program. Their objective is promoting student's mobility and knowledge from outside their disciplinary courses. These courses can be taken in other educational programs of the UANL, or in other domestic or foreign institutions with which the UANL has established academic agreements.

In our case, the teachers Amanda Melissa Casillas Zapata and Karen Hinojosa Hinojosa designed a course based in an existing free election LU called *Sustainable Ecological Environments,* incorporating the 11th SDG principles and the UANL Campus Team members' knowledge. While contemplating the particulars of SD goal 11: inclusivity, safety, sustainability and resilience, and the problems of the Metropolitan Area of Monterrey, the concept of healthy cities emerged. A healthy city "is one that is continually creating and improving those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and developing to their maximum potential" (WHO, 1998). Monterrey poses several threats to health as a city because of its pollution problem (Fernandez Delgadillo, 2016). Thus we resolved to integrate into our multidisciplinary course the Faculty of Public Health and Nutrition from the UANL.

After an organizational procedure, the LU called *Sustainable Ecological Environments* was offered to undergraduate students from the Nutrition program, and from the two undergraduate programs of the Faculty of Architecture: Architecture and Industrial Design. The mentioned LU has four selected students from the Nutrition program, five from Industrial Design who decided to take the course, and three students from Architecture who only have this option for their inscription. In order to have a multilevel course, we invited two Ph.D. in Architecture and Urban Studies students, although administratively they are taking the course as extra credit, not as part of their programs.

ADAPTING PBL TO AN EXISTING LU

The design of the final PBL module "*Sustainable Ecological Environments"* LU is made by the principles of Competency-based education (UANL, 2018); this course tackles urban problems with a multidisciplinary systemic approach. The course integrates the objectives of SD goal 11: inclusivity, safety, sustainability and resilience, around the problems of the Metropolitan Area of Monterrey and the big idea of healthy cities. The course encourages the ability to work in inter, multi and transdisciplinary teams. The course was given by five teachers, specialists in subjects like Bioclimatic Architecture, Urbanism, Public Space, and Social Sciences among others. Each teacher had at least four in person classes with the students.

During the 8th week of the semester, we received the CITYLAB Experts Visit. Heilyn Camacho Nuñez, from Aalborg University (Denmark), and Sandra Ornés Vásquez, from Simon Bolívar University (Venezuela) made two workshops with the students, and some workshops and conferences with teachers and students from the previously mentioned UANL faculties. Also, among the activities carried out during their visit, they worked in a world café with the group, where they shared their PBL experience in the midterm of the semester.

The 12 undergraduate students were divided in four teams integrated by scholars from different programs; meanwhile, the two Ph.D. students acted as Teaching Aides and supported the research of all teams. The students focused on the surrounding area of the UANL Health Campus. A part of the group was already familiarized with the area and had real life experiences with the problems they were identifying. That aspect was a trigger that motivated their research and site analysis. We confirmed that initial interest in learning can be triggered by personal relevance (Hidi & Renninger, 2006), when we observed great involvement particularly from students coming from the Nutrition program, probably because their faculty is located at that Campus.

The students used different research tools to investigate the site problems, such as surveys, mappings, photographic records, videos, among others. They detected a diversity of problems like insecurity, traffic or informal commerce, but showed more interest in working on the problem of pollution, particularly solid waste in the area. The students decided to analyze the pollution problem not only from a local perspective but regional, that made them conscious of the problem dimension.

The problem definition was one of the main challenges for students within the PBL course. Pollution and garbage have a significant impact on other site problems that they were recognizing during each session, this issue was studied from the perception of the environmental education that has an interdisciplinary approach to promote a change of conscience towards the environment. In this sense, the ability to identify the problem and establish parameters in the approach of the solution allowed them to develop a critical skill, a fundamental aspect that according with Savery (2015) students could developed when they worked with this learning methodology.

In addition, the problem formulation and analysis phase took longer than expected during the course, because of that the students realized the importance of working on their time management skills. However, spending more time on the analysis due to the lack of knowledge about the problem allowed them to develop their research capacity and encouraged them to apply what they have learned on the evaluation of their hypotheses and possible solutions, these reflects what several authors has point out about self-direct learning like Hmelo-Silver (2004).

At the beginning of the PBL course the students were confused and struggled with the transition of working with more than one teacher, after few classes they adapted and embraced the experience of facing the teacher as a facilitator that would guide them rather than just teach them. On the other hand, for the teachers, the challenge was in the adaptation of a program that implicated a lot of internal coordination and organization for the five teachers that were participating on the process.

The evaluation is used to determine the effectiveness of the projects that were designed to improve the teaching and learning process (Savin-Baden & Major, 2004). One of the difficulties we encountered while evaluating the problem-based learning process was that the UANL uses traditional models of evaluation that are both quantitative and summative. Based on that, it was necessary to adapt an integral evaluation to a numeric value, requiring the involvement of the professors and experts during the evaluation process. In the same way, the students contributed to the evaluation, with feedbacks through an online poll, about the course and their PBL experience.

At the end of the semester, the students made a public presentation at the main hallway of the School of Architecture. They designed two posters and edited a video that described the development process of their project.

SOME FINDINGS FROM THE *SUSTAINABLE ECOLOGICAL ENVIRONMENTS* LU

The CITYLAB Experts visit lends us to see that students are favorable to work in multidisciplinary teams. Nevertheless, the experts perceive that it is necessary to integrate more interfaculty elective projects along the university. Multidisciplinarity means a constructive challenge for teachers, because it involves a closer monitoring of the student's learning process. Our team found that time investment distributions are different than in a traditional course, and that going into the experience with that expectation eases the transition into this way of teaching.

The experts remarked that our LU shows a process which includes theoretical aspects, the approach with communities and exchanges between both faculties. We consider, as a next step, to deepen the collaborative work and the solutions from the perspective of the SDGs.

Retaking the PBL principles, our students are acquiring knowledge and they are developing skills to problem-solve, researching and responding to real problems. Our student teams found the experience invigorating and exciting, but not without challenges. The feedback they received from five teachers and two experts sometimes was contradictory, and assuming and accepting that some contradictions were part of the multidisciplinary working model was one of the unexpected learning outcomes for both teachers and students.

IMPLEMENTING THE PROJECT AFTER THE COURSE

The final part of the LU, was announcing the winner team for participating at the Bogota students' competition. Three students from the Nutrition program, one from Architecture and other from Industrial Design were chosen. They decided to integrate the main ideas of the course and put them in practice to at least partially solve or mitigate the solid waste pollution problem they had defined. During June and July the students actively developed their project. For example, between the 11th and the 15th June they made a "schedule of actions", a self-criticism of the winning project, and a redefinition of the project integrating other SDGs.

The following week, students reinforced their theoretical framework and they made a list of stakeholders. They contacted UANL's *UNIVERDE Federation* and they learned about some sustainable existing actions at the institution. It is important to mention that the UANL is recognized as the most sustainable university in Mexico by the Federal Government and some international rankings like the UI GreenMetric World University Ranking on Sustainability (UANL, 2018). During the last week of June and the first of July, the students decided to produce an activation with Health Campus students that integrated the recycling process, waste management, ecological awareness, and recreational activities to make the experience memorable. They used *gamification strategy*, consisting in applying the concepts and mechanics of games, but "in an atmosphere of non-gaming" (BBC, 2013). The students decided to launch their project during the "Welcome activities for new students" at the Faculty of Public Health and Nutrition.

Since the majority of solid waste found at the site came from recyclable materials from food and drink containers, students collected aluminum cans and plastic bottles. They created with them two "intuitive pots" (Figure 3).

Figure 3. Intuitive pots designed by the students.

Between the 9th and the 13th July the group prepared its participation at the previously mentioned event. The students built a brand and they called the team *"Garra Ecológica"* (Ecological Claw), inspired by the university's sport teams nickname and mascot, Tigers. Also, the team made a *sustainable Kit* for the participants that includes Tupperware, eco-bags, reusable silverware and Thermos. On Friday 13th the recreational activities and the sustainability campaign started at the Faculty of Public Health and Nutrition.

This participation is only an example of the activities related to the project that the team continues to develop. At the moment of finishing this paper, our students have been invited to be part of some sustainable projects inside the UANL, like their participation in an internal forum at the Faculty of Mechanical and Electrical Engineering (Figure 4).

Figure 4. Publicity for an internal students forum in Sustainability at the UANL.

PBL courses don't have the responsibility or the objective of solving real world problems. Problems are greatly motivating excuses, fertile ground for knowledge and skills to grow from confronting them. However, when contextual learning is relevant to the students of PBL courses, there is great potential for projects to take a life of their own and transcend the limits of their intended goals.

References

Askehave, Inger, Prehn, Heidi Linnemann, Pedersen, Jens & Pedersen, Morten Thorsø (2015). *PBL: Problem-Based Learning*. Aalborg Universitet: Aalborg. 25 p.

Barrows, Howard S. (1986) A Taxonomy of problem-based learning methods, *Medical Education*, 20. John Wiley & Sons: Oxford. pp. 481-486. https://doi.org/10.1111/j.1365-2923.1986.tb01386.x

BBC (2013). Salvar el planeta puede ser "un juego", *BBC News*, London, British Broadcasting Corporation, https://www.bbc.com/mundo/noticias/2013/03/130307_ciencia_juegos_salvar_planeta_jrg

FACULTAD DE ARQUITECTURA UANL (2018). *Plan de Estudios 402*, San Nicolás de los Garza, Universidad Autónoma de Nuevo León. http://arquitectura.uanl.mx/wp-content/uploads/2017/11/plan402_arquitectura.pdf

Fernandez Delgadillo, S. (2016). *Air quality deterioration in the Metropolitan Area of Monterrey is everyone's responsibility*. Secretariat of Research, Innovation and Sustainability of the Universidad Autónoma de Nuevo León. Retrieved from: http://sds.uanl.mx/en/air-quality-deterioration-in-the-metropolitan-area-of-monterrey-is-everyones-responsibility/

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. Educational Psychologist, 41(2), 111-127.

Hmelo-Silver, C. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, 16. Springer Publisher, pp. 235-266.

Salmon-Cox, L., Holzner, B., & PITTSBURGH UNIV., P. L. R. and D. C. (1977). Managing Multidisciplinarity: Building and Bridging Epistemologies in Educational R&D. Retrieved from http://0-search.ebscohost.com.millenium.itesm.mx/login.aspx?direct=true&db=eric&AN=ED135760&lang=es&site=eds-live

Savery, J. (2015). Overview of Problem-Based Learning: Definitions and Distinctions. In A. Walker, H. Leary, C. Hmelo-Silver, & P. Ertmer, Essential Readings in Problem-Based Learning (pp. 5-16). West Lafayette: Purdue University Press.

Savin-Baden, M. & Howell, Claire (2004). Foundations of Problem-based learning. Society for Research into Higher Education & Open University Press. Gran Bretaña.

UANL (2008). *Modelo Académico de la UANL*, Monterrey, Universidad Autónoma de Nuevo León, 44 p. http://www.uanl.mx/sites/default/files/dependencias/denms/modelo-educativo-uanl.pdf

UANL (2011). *Modelo Académico de Licenciatura*, Monterrey, Universidad Autónoma de Nuevo León, 24 p. http://www.uanl.mx/sites/default/files/dependencias/del/ma-lic11-web.pdf

UNDP (2015). *Sustainable Development Goals*, New York, United Nations Development Programme, 21 p. http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

UANL (2018). Gana la UANL el Premio al Mérito Ecológico 2018, *Sustentabilidad*, Monterrey, Universidad Autónoma de Nuevo León, http://sds.uanl.mx/gana-la-uanl-el-premio-al-merito-ecologico-2018/

WHO (1998). Health Promotion Glossary, Geneva, World Health Organization, p.13, Retrieved from: http://www.who.int/healthpromotion/about/HPR%20Glossary%201998.pdf?ua=1